

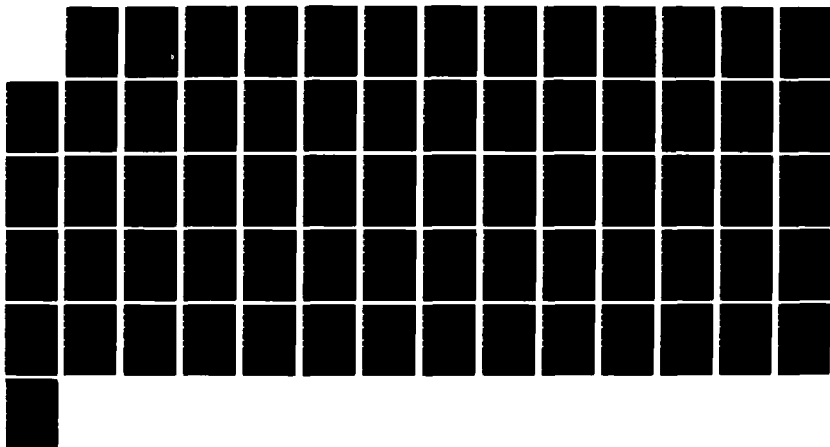
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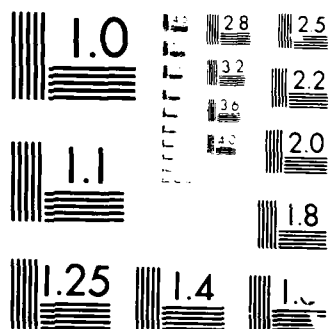
TACTICAL COMMAND AND CONTROL IN THE COMBINED ARMS  
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TACTICAL COMMAND AND CONTROL  
IN THE COMBINED ARMS BATTALION TASK FORCE

by

Major John C. Krysa  
Infantry

School of Advanced Military Studies  
U.S. Army Command and General Staff College  
Fort Leavenworth, Kansas

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Approved By:

Charles D. Daves

Monograph Director  
Lieutenant Colonel Charles D. Daves, M.S.

L. D. Holder

Director School of  
Colonel Leonard D. Holder, Jr., M.A. Advanced Military  
Studies

Philip J. Brookes

Philip J. Brookes, Ph.D.

Director, Graduate  
Degree Programs

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# ABSTRACT

TACTICAL COMMAND AND CONTROL IN THE COMBINED  
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This monograph examines the components and  
relationships in the tactical command and control system of  
the tank and mechanized infantry battalion task force.

The paper views command and control as a system from  
conceptual and functional perspectives. Beginning with the  
abstract, various theoretical models illustrate system  
functions and activity. Relevant battalion level doctrine  
is reviewed. The battlefield functional areas of maneuver  
control, fire support, air defense, combat service support,  
and intelligence and electronic warfare are addressed with  
emphasis on emerging developments affecting battalion  
operations.

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Tactical Command and Control  
in the Combined Arms Battalion Task Force

I. INTRODUCTION

The term "command and control" is attributed to the vocabulary of 1950's technocrats who were building the US continental air defense system of command centers, radars, missiles, and interceptor aircraft.<sup>1</sup> Nuclear weapons, national policy, political authority, and new methods of communication were pieces of a puzzle that were assembled together in a system of national command and control. The term became forever linked with military endeavor. In the Vietnam war, maneuver unit commanders used helicopters for "command and control" and the term became a part of the tactical unit's vernacular.

Most often command and control brings to mind notions of radios, echelons of headquarters, and operations order formats. It is almost always associated with battlefield communications for passing orders. Improvements in communications devices are equated with improvements in tactical command and control. These common aphorisms are misleading and inappropriate. Modern day command and control relies on hardware, but it is not just equipment.

In the conceptual spectrum of physical, moral, and cybernetic domains of war, command and control spans

all three domains dwelling most heavily in the latter. Command and control may have only recently entered the US Army's taxonomy but the theoretical functions embodied by the term have always been a component in combat between opposing armed forces.

The activity of command and control in a force serves to transform potential into combat power. Clausewitz writes that warfare is a duel, a physical encounter between opponents.<sup>2</sup> In actuality the opponents are not single individuals but masses of people and equipment. Command and control serves to unify and direct their action by providing structure and purpose.

The US Army's doctrinal manuals of the World War II era make no mention of command and control yet the subject is well covered. The manuals for tank and infantry battalions contain much of the activity we would equate with command and control in a modern day combined arms force.

Success in battle can be assured only by complete cooperation of all arms. No one arm wins battles. Success is attained when each arm, weapon, and individual is employed to afford the maximum mutual support.<sup>3</sup>

Control prior to attack is comparatively simple. Plans and orders are prepared and missions assigned. During an attack, control is necessarily decentralized, the degree of control that the battalion commander retains being directly dependent upon the thoroughness of his planning and the effectiveness of

his orders . . . Centralized control is regained during reorganization . . .4

Tank Battalion 1944

He (the battalion commander) encourages initiative, ingenuity, and aggressiveness among his company officers. Having indicated his policies and given his orders, he allows his subordinates maximum freedom of action to foster self-reliance and initiative. He supervises the carrying out of his orders . . . He meets this responsibility by anticipation; by timely decisions, plans, and orders; and by supervision of execution . . . He exercises his authority by means of instructions, orders, inspections, and personal supervision.<sup>5</sup>

Infantry Battalion, 1944

For our purposes command and control is a system. It includes equipment, procedures and the exercise of leadership. Retired Army LTG John Cushman, a noted command and control expert, views it as a "web that ties the force together."<sup>6</sup> The role of this "web" is becoming increasingly more important. The anticipated violence, pace, and intensity of future conflict make the strength of the cybernetic domain an important part of the spectrum.

The purpose of this monograph is to examine the components and relationships in the system of tactical command and control. The focus is on the tank and mechanized infantry battalion task force. It begins with the abstract realm by describing theoretical perspectives and tactical doctrine. The paper continues into the tangible realm with an exploration of the functional segments and the emerging technology

relevant to the battalion. It includes a description of possible improvements identified during battalion field operations.

Cooperation within the tank-armored infantry is continuous. All leaders study, plan, and prepare ways of coordinating the elements of the team to meet changing battlefield conditions.<sup>7</sup>

The Armored Infantry Company and Battalion, 1951

## II. COMMAND AND CONTROL THEORY

The system of command and control of a military force can be examined in terms of its conceptual components and the relationships between them. Various theoretical perspectives have been used to identify and explain the interactions of the diverse parts of an armed force in an effort to improve their efficiency and the effectiveness of the overall system.

A useful study for the Army was done by MITRE Corporation in 1985 entitled The Command, Control, and Subordinate Systems (CCS2) Functional Description. It views an organization as a system with three major parts: the work it is intended to perform, the people and equipment used to perform the work, and the information products and procedures which cause change. An organization's command and control system is part of a larger hierarchy. It is controlled by a higher echelon command and control system and in turn directs command and control systems of lower echelons. From this perspective an echelon of organization deals with

two forms of information; directives and status. A level of command receives directive information from lateral and higher levels. After processing, status information is passed upward and laterally and directive information is passed to lower levels. 8 MITRE's conceptual approach is readily applied to operational units. An operations order assigns missions to various organizations which require the application of their resources to achieve specific objectives. "Command and Control is the adaptive process employed by the commander to accomplish any number of operational missions." 9 Directive and status information is processed to issue orders, instructions, and guidance. Feedback of status information enables the commander to evaluate progress toward mission accomplishment and enemy reactions.

The processing of directive and status information is known as information transformation. This transformation is comprised of four distinct processes: planning, coordinating, directing, and controlling.

Planning endeavors to synthesize directive information with what is perceived about present and future conditions. In planning, the image of the situation is updated, alternate ways of allocating resources are examined, and the best means of achieving

the objective within current restraints and constraints is determined.

Coordinating is done to gather necessary assistance and negotiate a solution. Actions are taken to update various data bases, adjust subunit status to conform to planned uses of resources, and request additional resources.

Directing assigns objectives to subordinate levels. Specific tasks are given out and the desired situation is explained and clarified.

Controlling is a continuous procedure of comparing the perceived situation with the desired situation. It involves making decisions on appropriate responses to differences in what is actually believed to be happening with what is intended. The actions can be as simple as redirecting or may involve greater effort to recoordinate or replan.<sup>10</sup>

Another conceptual model of command and control was articulated in the proceedings of a 1985 Military Operations Research Society (MORS) workshop.<sup>11</sup> This model views command and control as a layered and interactive system. It discerns six sequential processes. These processes may be performed at one level or executed in a distributed manner at various levels. In simple systems some processes may not be consciously recognized as they are performed

reflexively or implicitly in certain actions. In complex systems the processes may be reordered and executed in uniquely designed loops.

The functional processes of the MORS C2 model are:

Sense - The function to collect data necessary for describing and forecasting the environment. It includes both the friendly and enemy forces' disposition and actions. Sensing also involves those aspects of the environment that are common to both forces such as weather, terrain, and neutral parties.

Assess - The function to transform data from the sense function into information about interactions and capabilities of enemy forces and about capabilities of friendly forces. Assessing serves the purpose of determining if deviation from the desired state warrants further action.

Generate - The function to develop alternative courses of action in order to correct deviations from the desired state.

Select - The function to select a preferred course of action from among the available options. It includes evaluating of each option in terms of criteria necessary to achieve the desired state.

Plan - The function to develop implementing details necessary to execute the selected course

of action.

Direct - The function to distribute decisions to the forces charged with executing of the decision.<sup>12</sup>

Another source of concepts is the 1987 draft of the Army Command and Control Master Plan (AC2MP.)<sup>13</sup> Of relevance to this paper are the portions on command and control operations concepts and tactical command and control development. The umbrella concept is stated as follows:

AirLand Battle doctrine and the AirLand Battle Future Concept describe the Army's approach to generating and applying combat power at the operational and tactical levels of war. To generate and apply combat power, military leaders must make sound and timely decisions and direct the activities of assigned and supporting units. The process for doing this is called "Command and Control," and the function of C2 is to generate and apply combat power decisively. Information is the medium of the C2 process, which has products of decisions and directives.<sup>14</sup>

The AC2MP models a four step process for all levels, from Theater Army to squad. The steps of acquire, assess, determine, and direct are described as follows.

Acquire information in the basic categories of mission, enemy, terrain, and troops available on a continual basis through a variety of means. Sources include personal observation, radio or telephone reports, data base updates via



automation equipment or digital transmissions, and personal discussions with aides, prisoners, frontline troops, subordinate leaders, and staffs. Mission information is received from higher echelons. Enemy and terrain information is received from intelligence processing systems, sensors, and human observers at higher, lower, and lateral echelons. Information about troops available, such as status and location, is provided by subordinate or supporting echelons. Information on other than subordinate units is received from higher and lateral echelons.

Assess if actions other than those previously ordered are required. This step seeks to ascertain if anything must be done differently from what is currently happening or intended, based on the information which has been acquired.

Determine feasible courses of action, analyze and compare them, and select one for implementation. This step employs some form of command and staff estimate process and results in a determination of appropriate action by a person authorized to make the decision.

Direct the implementation of decisions by planning, preparing, and issuing orders to subordinate and supporting units. This ensures

that subordinates remain consistent with the will of the commander by means of feedback.<sup>15</sup>

This last model of acquire-assess-determine-direct is easily applied to the command and control system of a battalion task force. It is clear to see the cybernetic nature of these steps and yet still see the relationships to the moral and physical domain. They offer a framework by which to structure the interactions needed to give purpose and organize the ways and means of a force to achieving an end. They involve the use of tangible, physical means for both command and control activity and for task oriented activity to accomplish the mission. They also are compatible with the intangible moral domain in the application of leadership and the exercise of command. All of this is interconnected by a web; the cybernetic ways of structuring the entire force.

This model fits well with the structure of a battalion to tie together subordinate and supporting units. It illustrates the entire command structure, not just the chain of command, and the control relationships. It applies to the tactical perspective of battalion operations and the technical perspective of communications and electronic devices. The assess and determine steps apply primarily to the exercise of command and rely on decisions and judgement. These

steps tend to center on commanders or subordinates authorized to act in their behalf for specific functions. The acquire and direct steps apply primarily to the function of control. They are concerned with assembling information for command decisions and then insuring that actions support the commanders concept.

### III. DOCTRINE

The first step in addressing doctrine is to identify the mission of the force. The battalion mission comes from its next higher echelon but the generic missions and capabilities are expressed in the battalion task force field manual and the tables of organization and equipment.

"The mission of the battalion task force is to close with and destroy enemy forces, using fires, movement, and shock effect in coordination with other arms."<sup>16</sup> The capabilities include attack, defend, delay, reconnaissance, raids, covering force, river crossing, rear area combat, and air assault or infiltration by dismounted infantry.<sup>17</sup> A complete listing of doctrinal capabilities is at Appendix A.

The next step is to describe the doctrine for command and control. As with leadership there are as many definitions of command and control as there are

authors. Starting at the top, Joint Chiefs of Staff Publication 1 gives the following:

#### Command and Control

The exercise of authority and direction by a properly designated commander over assigned forces in the accomplishment of the mission. Command and control functions are performed through an arrangement of personnel, equipment, communications, facilities, and procedures employed by a commander in planning, directing, coordinating, and controlling forces and operations in the accomplishment of the mission.<sup>18</sup>

The Army's macro perspective on command and control is expressed in the AirLand Battle doctrine of FM 100-5.

The command and control system which supports the execution of AirLand Battle doctrine must facilitate freedom to operate, delegation of authority, and leadership from any critical point on the battlefield.<sup>19</sup>

. . . The only purpose of command and control is to implement the commanders will in pursuit of the unit's objective.<sup>20</sup>

The last and lowest perspective on principles, procedures, and technique of task force command and control doctrine is FM 71-2J.

The purpose of the command and control system is to provide the commander accurate, timely information in order to make decisions, and assist him in preparing orders and supervising operations. The system must be responsive to mission requirements and effectively facilitate continuous planning, coordination, and assessment in every situation. <sup>21</sup>

These doctrinal perspectives begin with the abstract at the highest level and work down to the specific at the lower level. Common to all is the

emphasis on the personal dimension of command. This is important. No matter what the echelon, the role of the commander is to insure mission accomplishment. Procedures and facilities serve to extend the ability of the commander to see, think, and influence.

At the task force level, FM 22-103 relates to the battalion commander. This doctrinal publication, oriented toward senior professionals, tells battalion commanders that "command is the primary means whereby their vision is imparted to the organization." 22 It identifies four processes - command, control, leadership, and management. Command is a process geared toward coordinated but independent action to accomplish specified tasks effectively. Its characteristics are: vision of future conditions, clear intent and understandable objectives, low volume communication, and personal involvement. Control is described as an equal but conceptually subordinate process to provide structure in the face of uncertainty. Its characteristics are: efficiency of action, structure to establish parameters of subunit action and reduce uncertainty, high volume routine communication, and coordination. Management processes focus on conceptual relationships between units while leadership processes focus on interpersonal relationships between soldiers and their leaders. 23

The battalion task force doctrine for command and control systems identifies three components -- process, organization and facilities, and communications.<sup>24</sup> The process section contains such things as decision making steps, troop leading procedures, orders formats, and checklists for specific operations. These are all techniques for providing structure. They are a way of establishing routines, delineating recurring responsibilities, and insuring a sequence of preparatory activity before decisions are made and action initiated. The organization and facilities section contains such things as command group and tactical operations center (TOC) composition and logistics center and trains echelonment and composition. These are all suggested methods of allocating information processing assets; people, and equipment. They insure an efficient distribution of control activity and redundancy of multifunction control centers should one installation be destroyed. The communications section contains such things as responsibilities for establishing and operating communications links, procedures for ensuring effective communication despite possible disruptions, and composition of radio and wire nets. These are all techniques and organizations to foster the efficient

exchange of information and proper access to categories of information.

Where individual determinations must be made in any manner of complex problem solving, principles are been useful conceptual guideposts. The following principles of command and control were identified by LTC Garber in an Army War College study project.<sup>25</sup>

While these principles are not part of our approved doctrine, they seem useful for stimulating thought on the application of doctrinal concepts.

1. "The commander's intent must be clearly understood." When direct contact is lost, subordinates must have a clear and common understanding of what is required in order to act independently towards a common end.<sup>26</sup>

2. "A key ingredient in establishing the commanders intent is pesonal contact between commanders." Face to face contact is a function of command and accomplishes more than improved communication. Automation is only a supplement.<sup>27</sup>

3. "The combat arms commander must be positioned well forward to command and control his forces." The battalion commander must physically observe the battle to be effective.<sup>28</sup>

4. "Accurate reconnaissance and information is essential." The commander must see the battlefield

from more than one perspective. Directed telescopes, reports from subordinate commanders, and hard intelligence give necessary observations.<sup>29</sup>

5. "Decentralization and flexibility have been characteristic of past successful operations."

Trained, enlightened, and courageous subordinates must exercise initiative for victory in battle.

Technological advances to assemble data for the commander must not cause centralized control to be routine.<sup>30</sup>

6. "Combat orders must be brief and concise."

Subordinates need minimum essential information to guide their decisions and actions. Lengthy detailed orders and volumes of non-essential information are restrictive and disruptive.<sup>31</sup>

7. "Leaders must be able to communicate constantly."

Dependable, uninterrupted communication fosters rapid coordinated response to battlefield opportunities.<sup>32</sup>

In a broad sense the doctrine provides a framework for applying the theoretical model of acquire, assess, determine, direct. Doctrine manuals contain suggested techniques for getting the mission accomplished. The variations of the battalion task force's missions can be accommodated by the general structure of the doctrine. The specific techniques, allocation of responsibilities, and organization of assets ought not



be standardized for all missions. A change of mission may require changes in task organization. Changes in the environment (i.e. mountains, urban areas, chemical contamination) may require changes in tactics or methods of operation. One fixed organization, structure, or set of procedures for command and control may not be appropriate for all circumstances. There are a wide range of assets which contribute to the combat power of a battalion and the commander must determine the optimal ways for employing and controlling each of them for every changed situation.

#### IV. BATTLEFIELD FUNCTIONAL AREAS

The AC2MP breaks down the architecture for command and control into five segments or Battlefield Functional Areas (BFAs.) They are maneuver, intelligence and electronic warfare, fire support, air defense, and combat service support. These functional areas are found at each echelon of a force, from corps level through battalion. For each BFA there are unique systems with sets of people, procedures, and material. (See Appendix B for diagrams of functions and interfaces.)

The general functions of these segments are:

- Transform data into useful information to develop decisions concerning the employment and sustainment of combat power appropriate to that

BFA.

- Disseminate guidance and orders from the commander and staff to direct subordinate and supporting units.
- Coordinate among other BFA subsystems. 33

Each BFA has its own structure. Control elements are found at various levels of the force from corps to battalion, but not necessarily at every level. While each level of command must have access to functional information in order to share and exchange it, for decision making, not every level has the capacity to gather, assess, and process data. The rapid exchange of processed information is the object. (See Appendix C for locations of control elements within tactical organizations.)

The air portions of AirLand Battle command and control are found in each BFA. While air is a critical dimension of the total force, the ground maneuver battalion headquarters is limited in the command and control of air assets. A matrix of the battalion's relationships in Army Airspace Command and Control (A2C2) is at Appendix D. Where appropriate, battalion involvement with air assets are mentioned in the individual BFA subsections.

The remainder of this section describes the specific functions of each BFA. Special emphasis is

given to future technological developments affecting the heavy battalion task force.

#### A. Maneuver

The maneuver control segment serves to develop and carry out the AirLand Battle scheme of maneuver portion of the unit's concept of the operation to accomplish the assigned mission. It also includes command, control, and communications counter-measures (C3CM) to protect and enhance the effectiveness of the force's total command and control system.<sup>34</sup>

At the present time, most combat arms battalions perform a majority of these functions with manual systems and procedures. A variety of technological advances are on the horizon which will speed the command and control process for tactical forces. While these planned programs apply from corps to battalion level, a closer review indicates that the battalion level headquarters remains the least modernized by new devices. Radical changes will take place at the higher levels if and when these programs are implemented. The emerging systems which appear to most affect the maneuver segment of battalion command and control are: Maneuver Control System, Mobile Subscriber Equipment, Single Channel Ground and Airborne Radio System, Small Unit Radio, and Enhanced Position Location Reporting System.

The first program is the Maneuver Control System (MCS). This automated system is intended to manage battlefield information, aid decision making, and speed the issuance of orders and command directives. It is a network of independent computers, each one of which functions by itself but links to others to exchange information. The system does not depend on a central node or main computer whose destruction would disrupt the entire network.<sup>35</sup>

What this system is capable of providing to a battalion is indeed impressive. Tactical Computer Terminals (TCT), Tactical Computer Processors (TCP), and Analyst Consoles (AC) are the major MCS components at levels from corps thru brigade. At battalion level a Battalion Terminal (BT) will be installed in existing vehicles. The BT can depict situation maps of variable scale with a variety of overlays, task organization, unit status, decision graphics, and preformatted messages. The BT can exchange this information with other maneuver control terminals or other BFA terminals at higher and lateral levels of command. It accomplishes this by secure digital transmission over the unit's standard radios. An accompanying large printer/plotter can produce copies of the information as well as print paper and acetate map overlays. (For

a more detailed listing of MCS operational characteristics see Appendix E.)

The next emerging system is Mobile Subscriber Equipment (MSE.) This communications program will form an area system for voice and data exchange throughout the division and corps areas. Signal battalions will establish a network of interconnecting nodes. The end result will be similar to communications in the civil sector between car and office using mobile cellular telephones. Users need only pick up their handset and push the buttons as they would on a touch tone telephone in a car or office. By a redundant grid of radio, field wire, or commercial telephone links, normal voice conversations or digital data exchange can be accomplished with a high degree of dependability. 36

The maneuver battalion will only benefit indirectly as this system provides complete service from the brigade level on up. The battalion is expected to have a mobile radio telephone for the commander and two wire telephones which are intended for use by the field trains. However, the MSE system is designed to be interoperable with the battalion's current and planned radios. In this way the battalion's MCS terminals can exchange data with other units throughout the corps. MSE will replace current multichannel systems while remaining compatible with

them and will be also inter-operable with tactical satellite, NATO, and echelons above corps communications systems.<sup>37</sup>

The next system is Single Channel Ground and Airborne Radio System (SINGARS.) It is a "secure, frequency hopping, single channel VHF-FM radio that will be used in combat, combat support, and combat service support units from squad through corps."<sup>38</sup> This new radio system will replace the current AN/VRC-12 series radios.

The battalion will benefit substantially from the SINGARS. Its vehicle mounted planning range is 35 kilometers. It will come in both vehicle and man pack configurations. The system is designed to be interoperable with NATO tactical radios and VRC-12 series equipment it is replacing when set in a the single channel mode. While it is primarily a voice radio, it should interface with other communications links for data transmission without adjustment.

The Small Unit Radio (SUR) is the long desired hand held walkie talkie. This convenient radio is intended for use as a platoon command net, primarily for dismounted operations. It is capable of secure communications and has a planning range of 3 kilometers. A vehicle mounted version will be provided for field artillery units and a non-hardened version

provided for combat support and combat service support units. These simple radios will offer the various platoons and teams which operate in the battalion area their own low power radio links.<sup>39</sup>

The last system with direct impact on battalion operations is Enhanced Position Location Reporting System (EPLRS). Units will be furnished terminals weighing 26 pounds consisting of a radio transmitter, a readout unit, and an antenna mast. The terminals are either man pack or vehicle mounted. A battalion's terminals will connect with a grid communications system established by higher echelons of command.<sup>40</sup>

EPLARS uses a data communications system with a low capacity. It will accurately provide the user with his position in Mercator grid coordinates or latitude/longitude on a hand held readout device. It also transmits the user's location to MCS. The system can carry limited amounts of data in support of other BFA systems in addition to position and navigation information. The main benefits are accurate navigation for the user and automatic position reporting to the battalion MCS terminal.

#### B. Intelligence and Electronic Warfare

On the dynamic battlefield, commanders require timely, accurate intelligence to support decision making. The vast amount of combat information and intelligence collected by national, theater and tactical

systems demands that intelligence analysis, production and collection management be supported with automation... The tactical IEW architecture will support decision making through the rapid processing of large volumes of combat information and intelligence from all sources and by providing timely targeting information and threat assessments.<sup>41</sup>

At the battalion level, the Intelligence and Electronic Warfare (IEW) functional area is concerned with producing and monitoring information about the enemy situation, reconnaissance, surveillance, topography and terrain, sensors, targeting information, and denying the enemy access to friendly information. In the emerging IEW structure most of the intelligence processing and analysis will be done at higher levels. Electronic warfare is almost exclusively a division or higher level function.

Information regarding the enemy, weather, and terrain is essential for success in combat. The battalion S-2 section must provide this information to the commander in timely, accurate, and concise packages. In the emerging IEW architecture, battalion assets primarily receive intelligence products from higher levels and pass reports and local enemy information from subordinate units back. The battalion intelligence section is more of a consumer of information than a producer of intelligence.



The All Source Analysis System (ASAS) will be supported by a range of automation programs at the division and corps levels. The battalion is not a major part of ASAS. However, the battalion will be provided with non-ASAS automation to aid in its intelligence processing and analysis functions. Also, an MCS battalion terminal will link the battalion with processed information available from higher echelons. Intelligence preparation of the battlefield will be greatly assisted by the capabilities of the MCS terminal for terrain analysis and tracking the enemy situation.<sup>42</sup>

In regard to the air dimension of the battlefield, the IEW function at battalion level has little or no involvement in initiating collection activity. The major role relates to evaluating terrain as a factor in helicopter operations, either friendly or enemy. Of lesser likelihood is the nomination of missions for Air Force recon aircraft or Army special electronic mission aircraft.

#### C. Fire Support

The fire support BFA serves to develop and execute the plan of fire support portion of a unit's concept of the operation. The object is to "influence and defeat surface targets by active indirect fire means and the units that execute these actions."<sup>43</sup>

This functional area has been the object of technological improvements for faster and more efficient command and control for many years. In the 1960's the Field Artillery Digital Automated Computer (FADAC) was developed to automate fire direction. That system was replaced by the Tactical Fire Direction System (TACFIRE) and the Battery Computer System (BCS). These systems are proving themselves to be unsatisfactory for meeting the demands of future conflict. This set of equipment which has been difficult to maintain and operate "has reached the upper limit of its capabilities and the technology used to implement the system is nearing obsolescence."<sup>44</sup>

The technology of the future is the Advanced Field Artillery Tactical Data System (AFATDS). This system will provide automation and linkage between artillery headquarters, firing units, target acquisition units, and the fire support elements (FSE) at all echelons. It is also intended to include the air dimension in fire support. AFATDS will apply technological advances to the activities of fire support planning, fire support execution, field artillery fire direction center operations, and field artillery movement control.<sup>45</sup>

The battalion task force is dependent upon supporting units for personnel, material, and

organizations which plan and execute indirect fires. Within the current battalion structure, the only organic fire support assets are found in the heavy mortar platoon. The direct support artillery battalion must provide a fire support element in the form of a battalion fire support officer (FSO) and company fire support teams (FIST). Effective tactical air support depends upon an Air Force tactical air control party (TACP). Close coordination with Army Aviation units may depend on the presence of an Aviation liaison officer or scout helicopter.

The FSE provides the link between artillery and mortar fires and the maneuver force. At present, FSE digital message devices (DMD) are the means of calling for artillery fires. The FIST teams are also the only forward observers for mortar fire. The FSO is a key player in the fire planning process and for executing responsive indirect fire. In special situations, an aerial forward observer with a specially configured OH58-D helicopter from the artillery section of the Division Artillery Brigade may be furnished by the DIVARTY.

Close air support is most effectively planned and employed with the support of a full time battalion Air Liaison Officer (ALO). The TACP provides the commander with an effective link to the firepower of Air Force

systems. While air support may be requested thru maneuver control links with the brigade headquarters, an ALO is the best person to articulate the maneuver commanders requirements. The TACP provides the communications systems and expertise for rapid air support requests, coordinating support with the FSO and airspace management element, and terminal attack control.<sup>46</sup>

#### D. Air Defense

The air defense BFA serves to "develop and direct the air defense concept of operation to influence and protect airspace of the AirLand force and defeat aerial targets in support of the AirLand force concept of operation."<sup>47</sup>

Currently, the battalion task force depends on its own visual observations of the sky and voice radio nets for air defense status and early warning of air attack. The supporting Short Range Air Defense Artillery (SHORAD) systems located in the proximity of a maneuver force or attached to it are no better off. Air surveillance is by means of obsolescent radar systems. Alerting and directing mechanisms for firing systems are inadequate. The only real command and control of air defense weapons in the battalion area is done by positioning weapons within the formation and issuing the air defense weapons control status.

The conceptual approach to correcting these serious deficiencies is the Forward Area Air Defense Command Control and Intelligence (FAADC2I) program. This package calls for the development of a system to acquire, process, and disseminate air tracking and identification data to firing elements; provide early warning and alerts to other forces; and interface with the other BFA control systems. It is envisioned that targeting data obtained by ADA control elements from Army sensors or the Air Force via the Joint Tactical Information Distribution System (JTIDS) would be sent to firing elements by data link over the EPLRS network.<sup>48</sup>

One technological advance which is already being fielded is the Improved High Frequency Radio (IHFR). This new radio will benefit the maneuver battalion in the form of improved air defense early warning within the higher echelons of the ADA functional area. The IHFR will replace the AN/GRC-106 HF radio in communications links as far forward as ADA liaison officers to the maneuver units and down to SHORAD platoons.<sup>49</sup>

#### E. Combat Service Support

The function of the Combat Service Support Control System (CSS/CS) segment is to "develop and direct the CSS concept of operation to sustain and reconstitute

the AirLand force in support of the AirLand force concept of operation."50

The CSSCS is an automation modernization program for processing logistics data, mainly from the current Standard Management Information Systems (STAMIS). The system will organize data into two information groupings. One grouping will be oriented on the information needs of commanders and the other for staff planning. CSSCS is the means of "providing the force level commander with the important information he needs to use CSS resourcing as a combat multiplier" and "exercising effective command and control of CSS units to accomplish the CSS mission."51

From the battalion task force perspective, CSSCS improves the ability of those who support the battalion logisticians. It does not automate task force logistics. Battalion CSS functions are more directly affected by sustainment data processed thru MCS battalion terminals. The CSSCS hardware stops at the brigade level. MCS hardware is a major improvement in the task force's CSS functional area. Battalion MSE telephones link task force administration and logistics activities in the brigade support area with higher level activities. The execution of various CSS activities will also benefit from the new radio systems described in the Maneuver BFA.

From the air perspective, helicopter lift and resupply are the most probable CSS activities. the command and control aspects of these activities will be accomplished by systems in the Maneuver BFA.

#### V. TASK FORCE IMPROVEMENTS

As the Army goes about its activities of training and exercising to prepare for combat, it observes shortcomings and inadequacies. These observations become the basis for taking action to improve our performance in the future. The object is improved readiness.

One major laboratory for testing battalion task force operations is the National Training Center. A recent unit training period was designated as a Command and Control system focused rotation. Representatives of the major branch schools prepared written observations in their areas of interest. There are thirty observations in the after action packet. The observations were placed into four categories by their authors with some observations being placed in more than one category.<sup>52</sup>

This report is a collection of individual observations but a content analysis of the actual topics described yields some interesting insights. The

original categories and number of observations were: doctrine/ 25, training/ 6, organization/ 0, and equipment/ 5. It seemed odd that a majority of suggested improvements dealt with doctrine. A more discriminating codification might have moved many of the doctrine issues into the other categories, especially organization. A number of issues dealt with the composition and structure of groups like headquarters, patrols, and obstacle breaching teams. While these may be addressed in doctrinal manuals they are really matters of organization.

The four categories were reasonable as they involve TRADOC products. It seemed that resorting observations by different categories might better reveal the nature of the shortcomings. The first alternative was the four steps in the AC2MP model. The results were a nearly equal distribution: acquire/ 11, assess/ 11, determine/ 14, and direct/ 14. The second alternative was sorting into the single most relevant functional area. The results were: maneuver control/ 13, fire support/ 3, air defense/ 2, intelligence and electronic warfare/ 5, and combat service support/ 7.

A close review of each issue reveals some questionable recommendations. The suggested improvements range from the reasonable to the absurd.



There are valuable and workable techniques in this report but they are not appropriate for standardized adoption by every mechanized infantry and armor task force in the Army.

In the functional area of maneuver control the issues fall primarily into establishing more definitive guidelines for procedures and responsibilities. They include such items as: articulate "why" in commander's intent, fix duties of XO/2IC, organization for breaching drills, appoint CINC bulldozer, define criteria for halting an attack, define chemlite marking system, make back briefs a requirement of orders issuance, and establish procedures for XO to assume command. In the NTC task force mode of conducting a continuous series of changing missions some standardization may be possible. The enemy remains the same. Obstacles always consist of combinations of concertina wire, surface laid mines, or ditches. The "one best way" may not work best everywhere in the world.

The following is a review of techniques for improving command and control extracted from the NTC Rotation 86-6 report and a taped address to the Armor School by a senior Task Force Observer/Controller. They are organized by battlefield functional area.<sup>53</sup>

The first group is maneuver control. The confusion of battle and disruption of communications will require subordinates to act independently. To enable these independent actions to be correct and in harmony with the total operation, a clear concept of the intended conduct of the battle is essential. This information may be phrased in a commander's intent or concept of the operation. The improvement techniques are face to face orders, back briefs by key subordinates (both maneuver and fire support), and predetermined plays or battle drills. Teamwork is essential for task force units to function without continuous communication. SOP's must be practiced if they are to be useful for reducing routine communication. Teamwork comes from practicing, rehearsing, and understanding the actions which must be taken when certain circumstances exist.

Improving the quality and speed of communications is another area to benefit maneuver control. Some techniques include always using a common language or precise operational terms to shorten conversations without reducing understanding. Brevity codes of routine prowords to further shorten directives and status reports. Vehicle marking systems with distinctively shaped panels or chemlite color codes and patterns reduce the need for radio calls to identify

subunit positions. A Terrain Index Reference System (TIRS) can speed the transmission of position information for small units without always encrypting grid coordinates. Alternatives to radio such as runners, flag signals, or pyrotechnics should be planned as backup systems. Reproduction of written communications should be anticipated and practiced with devices like mimeograph machines, jelly roll, carbonless transfer paper, microcomputer printers, or preformatted orders tablets. Lastly, eavesdrop on specific radio nets and take action as required without personally responding. Commanders operate on one net while XO's or principal assistants monitor, pass orders or information on other nets and then advise their commanders as appropriate.

The next category is fire support. The techniques for improving the fire support functional area are quite simple. The FSO must accompany the task force commander in battle to see what he sees and have continuous communication by conversation and gestures. The FSO's electronic communication devices must be with him, ideally in the commander's vehicle. Fire planning must include coordination with the DS artillery battalion to anticipate what units will deliver fires at specific phases of an operation and which planned fires are expected to be critical. This will improve

the control of fires in support of the concept of the operation by reducing the reliance on on-call targets. Air attacks, either by Army or Air Force, must be planned as part of the operation to serve a deliberate purpose.

Air defense is the next category. The techniques tended to reduce the need for centralized control. Stinger teams would be placed in tracked vehicles to accompany maneuver companies or in Vulcan carriers under the ADA platoon leaders control. An attached or DS ADA platoon would be told which maneuver unit to follow or base its movement on and directed to monitor the task force command net.

Intelligence and electronic warfare techniques dwell on acquiring information. Scouts are the only dependable means of collecting intelligence at NTC. To improve their capability the attachment of tank sections infantry squads, ground surveillance radars, engineer obstacle teams, or improved TOW vehicles may be appropriate. Dismounted patrols and listening posts are an often overlooked technique of collection. The TACP should query aircraft in the vicinity for relevant information and pass it to the S-2.

The last category of combat service support is oriented on standard procedures to reduce situational decisions. Trains displacement authority, unit

resupply, casualty evacuation by line units, and administration/logistics operation center decision authority should be determined before an operation and the procedures for executing them rehearsed.

Not all of the previously described improvements are new and innovative. Most may have been considered or used before. What is important is that problems or inefficiencies in command and control systems are continually arising. A perfectly designed system, once implemented, will not stay perfect. It needs continuous attention and periodic adjustment to changed with prevailing conditions.

During a previous period of modernizations the Army made many improvements and changes because of peacetime exercises. In the opening days of World War II much was learned during the Tennessee and Carolina maneuvers. They showed that the regimental system had much to offer in terms of combined arms combat power. In another development, tank destroyer battalions were proved to be effective when independently employed during exercises.<sup>54</sup> Yet combat was to prove differently. Among other lessons, the fight at Kasserine Pass was to show that existing methods of organization and control were ineffective in modern war. American's First Battles describes this situation stating "the regimental echelon was abolished and the

battalion became the basic unit." 55 A study by Dr. Gabel describes a wide range of organizational and control structures which were ultimately used to command anti tank systems throughout the war.<sup>56</sup> The techniques of improvement discovered during precombat exercises did not always provide the right solution to the hard reality of combat.

#### VI. CONCLUSION

In the high intensity combat of future battlefields the combined arms task force must work as a team and use every asset efficiently. The application of combat power against a determined opponent will not be a simple task. The function of battalion command and control systems must be the rapid application of combat power in the most effective manner possible.

The command and control system can be likened to the brain and the nervous system of the body. It thinks, remembers, applies instinct, concentrates, relaxes, passes innumerable messages within the system automatically and causes external communications when desired. Similarly the command and control system of a unit must serve the same functions. The commander's concept, will, and determination are carried to all parts of his force. All components must function harmoniously. Some actions in the duel between forces

are directed, others, reflexive. Functions of necessary sustainment happen involuntarily and priorities of support change with the nature of the actions.

Modern combat is the competition of one organized force against another. In that competition, speed, accuracy, mass and sustainability are important only in the aggregate, not by themselves. It is in relation to the enemy that collective superiority is required. For example, identifying an enemy vulnerability faster than he realizes it exists is irrelevant; identifying and acting on it faster than the enemy is decisive. If the enemy can move forces quicker, then we must improve our system's ability to acquire, assess, determine, and direct action faster and more accurately than the enemy to overcome his one advantage. Simply reporting more quickly or deciding quickly may not be enough. The entire system must be better and faster than the enemy's.

The development of a superior command and control system depends on the commander and the traditional factors of mission, enemy, terrain, troops available, and time (METT-T). Theories and concepts explain the interactions between parts of a force. Doctrine provides a standardized framework and common language for the accomplishing required tasks. Technology may

speed some functions. Techniques and procedures must constantly be improved to accomidate a changing METT-T.

The commander must insure his system furnishes the right information, in a useful form, to the right people, who take the appropriate actions in a timely manner for his force to be dominant in battle. "The ultimate measure of command and control effectiveness is whether the force functions more effectively and more quickly than the enemy."57



## APPENDIX A. Battalion Capabilities and Dependencies

Task Force Capabilities, FM 7-2J p 1-33.

1. Conduct continuous operations, 24 hours a day.
2. Move to contact independently, or as part of a larger force.
3. Attack to seize, overrun, penetrate, or envelop prepared enemy defenses or strongpoints.
4. Conduct exploitation and pursuit operations as part of a larger force.
5. Conduct reconnaissance in force and raids.
6. Defend from or attack villages, towns, and strip areas.
7. Continue operations in all weather and visibility to include night operations.
8. Operate in an NBC and EW environment.
9. Defend or delay in sector.
10. Operate as part of the covering force of a larger unit.
11. Move rapidly in any direction to defend from battle positions.
12. Conduct river-crossing operations.
13. Conduct near area combat operations.
14. Defend from battalion or company-size strongpoints.
15. Mechanized infantry also has the capability of conducting air assault operations.
16. Mechanized infantry also has the capability of conducting infiltration operations.

Infantry Battalion (Mechanized) TOE 07245L0

Capabilities:

1. Provides a base of fire and maneuver elements.
2. Seizes and holds terrain.
3. Conducts independent operations on a limited scale.
4. Provides antitank protection for organic and attached units.
5. Provides mortar fire support for organic and attached units.
6. Conducts long-range patrolling.
7. Provides a high degree of cross country mobility to successfully exploit the effects of nuclear and non-nuclear weapons.
8. Provides a force that complements and enhances the inherent capabilities of tank elements, when employed in tank/infantry teams.
9. Provides a force that can participate in air-mobile operations when provided with air transport.
10. Maneuvers in all types of terrain under all climatic conditions.
11. Participates in amphibious operations.
12. Participates in counterinsurgency operations as elements of brigade-size backup forces

Dependent Upon:

1. Appropriate divisional or corps elements for legal, finance, personnel, and administrative services; and unit level maintenance on organic medical equipment.
2. US Air Force Tactical Air Control Party (TACP) for directing tactical air support.
3. Supporting artillery battalions for a Fire Support Section and Company Fire Support Teams (FIST) for observation and coordination of fire support.

## Tank Battalion TOE 17375L0

### Capabilities:

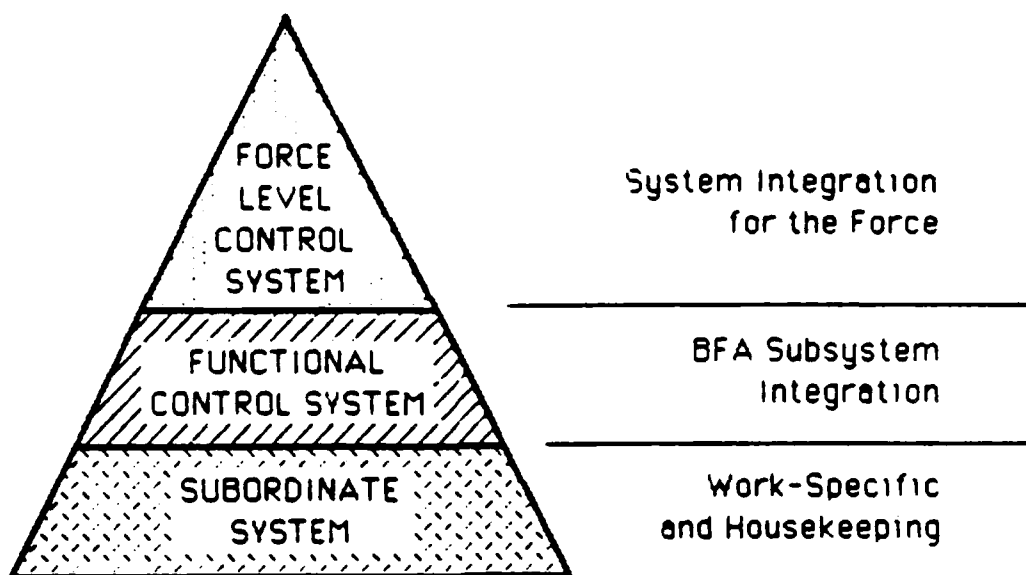
1. Conducts operations requiring a high degree of firepower, mobility, armor protection, and shock effect.
2. Attacks or defends under hostile fire and during limited visibility conditions.
3. Destroys enemy mounted and dismounted forces.
4. Commands, controls, and maneuvers tank and mechanized infantry through cross-attachment with mechanized infantry battalions to engage the enemy in the conduct of mobile warfare.
5. Provides mobility, armor protections, firepower, and flexible communications to successfully exploit the integrated use of conventional, nuclear, and chemical fires.
6. Provides combat service support to the headquarters and tank companies, to include resupply, maintenance, health services, mess, and unit level administration support.

### Dependend Upon:

1. Appropriate elements of the division and/or corps for legal, finance, personnel and administration support.
2. A US Air Force Tactical Air Control Party for directing tactical air support.
3. Supporting artillery battalion for a fire support section and company fire support teams (FIST) for observation and coordination of fire support.
4. Division artillery, TOE 06300J2. For nuclear fire support.

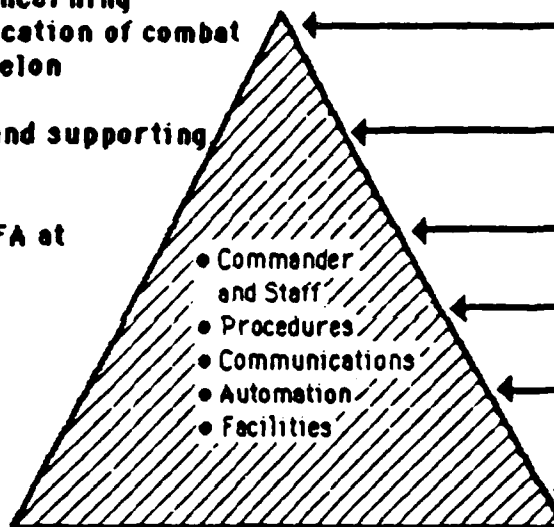
## APPENDIX B Battlefield Functional Area Interfaces

The following diagrams were extracted from the Army Command and Control Master Plan. They serve to illustrate the placement of the functional areas within the hierarchy of the command and control system and the common interfaces of all battlefield functional areas.



## FUNCTIONS

- Develop decisions concerning generation and application of combat power of a force echelon
- Direct subordinate and supporting units of a force
- Coordinate across BFA at each force level



## INTERFACES

Higher Echelon  
Force Level Control System

Adjacent Echelon  
Force Level Control System

Lower Echelon  
Force Level Control System

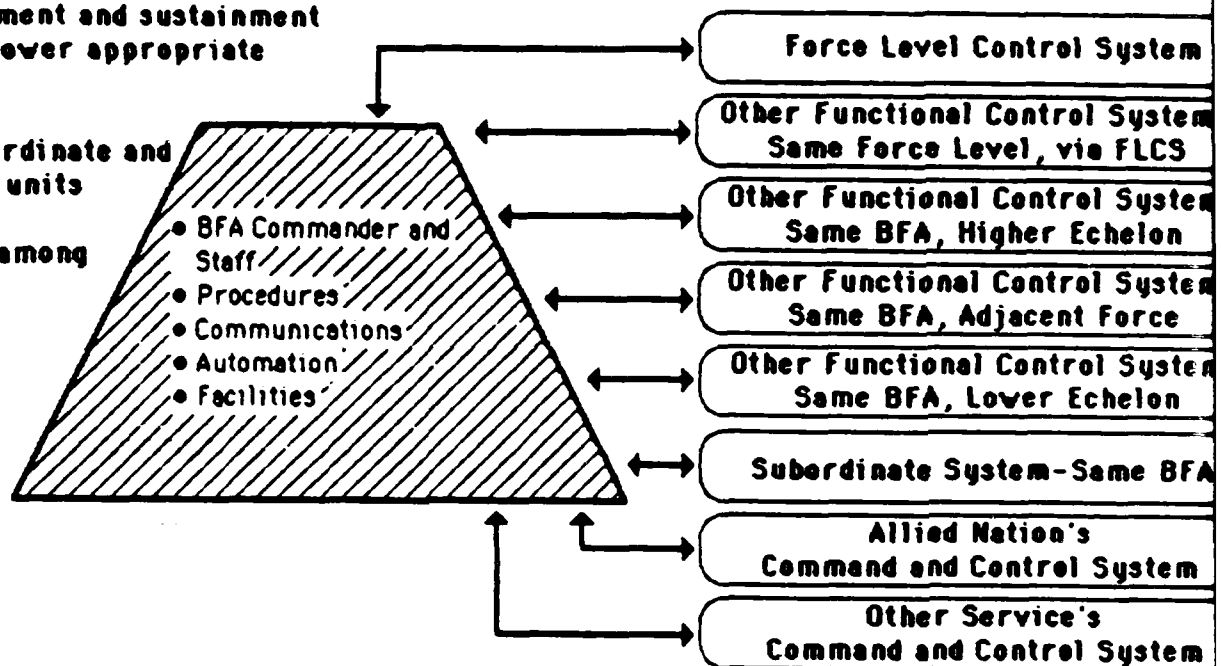
Functional Control System

Other Nation's Command  
and Control Systems

Other Service's Command  
and Control Systems

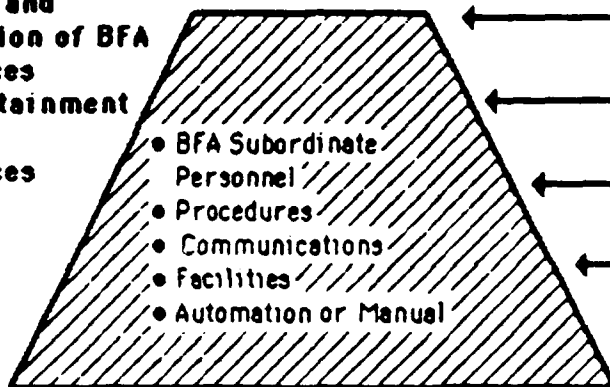
## FUNCTIONS

- Develop decisions concerning the employment and sustainment of combat power appropriate to that BFA
- Direct subordinate and supporting units
- Coordinate among subsystems within the BFA



## FUNCTIONS

- BFA Work-Specific
- Housekeeping:
  - Intra-BFA Communications
  - Security and Protection of BFA Resources
  - Self-Sustainment of BFA Resources



## INTERFACES

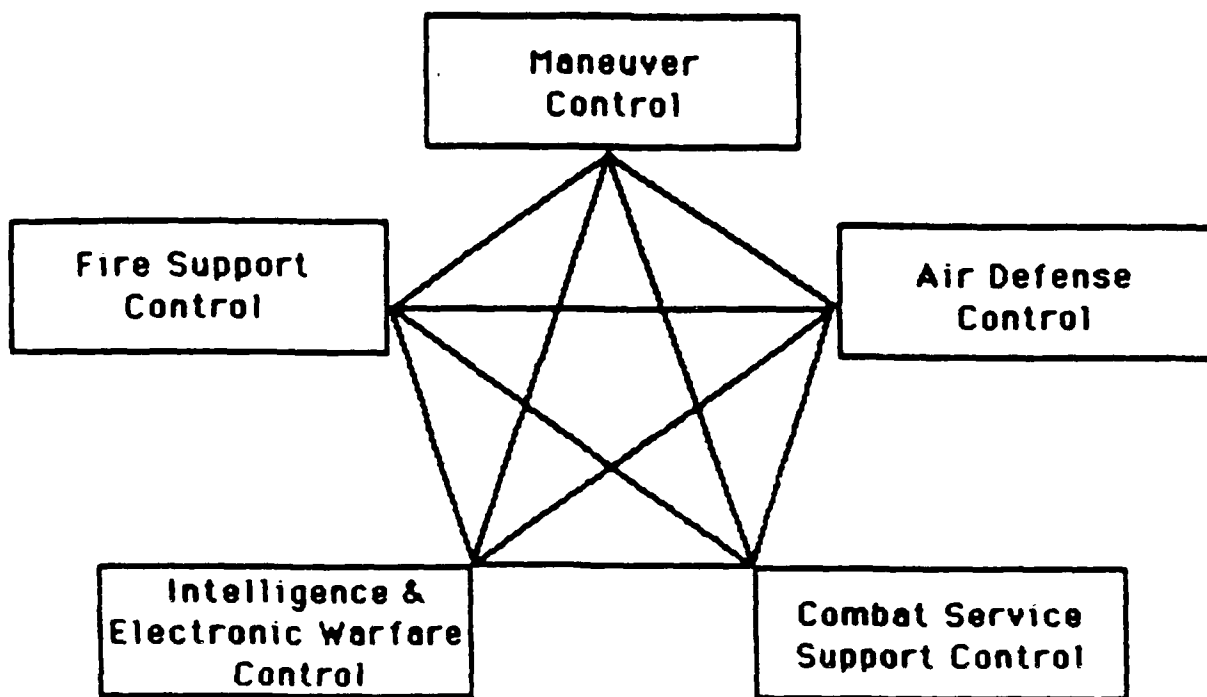
Functional Control System

Other Subordinate System-Same BFA

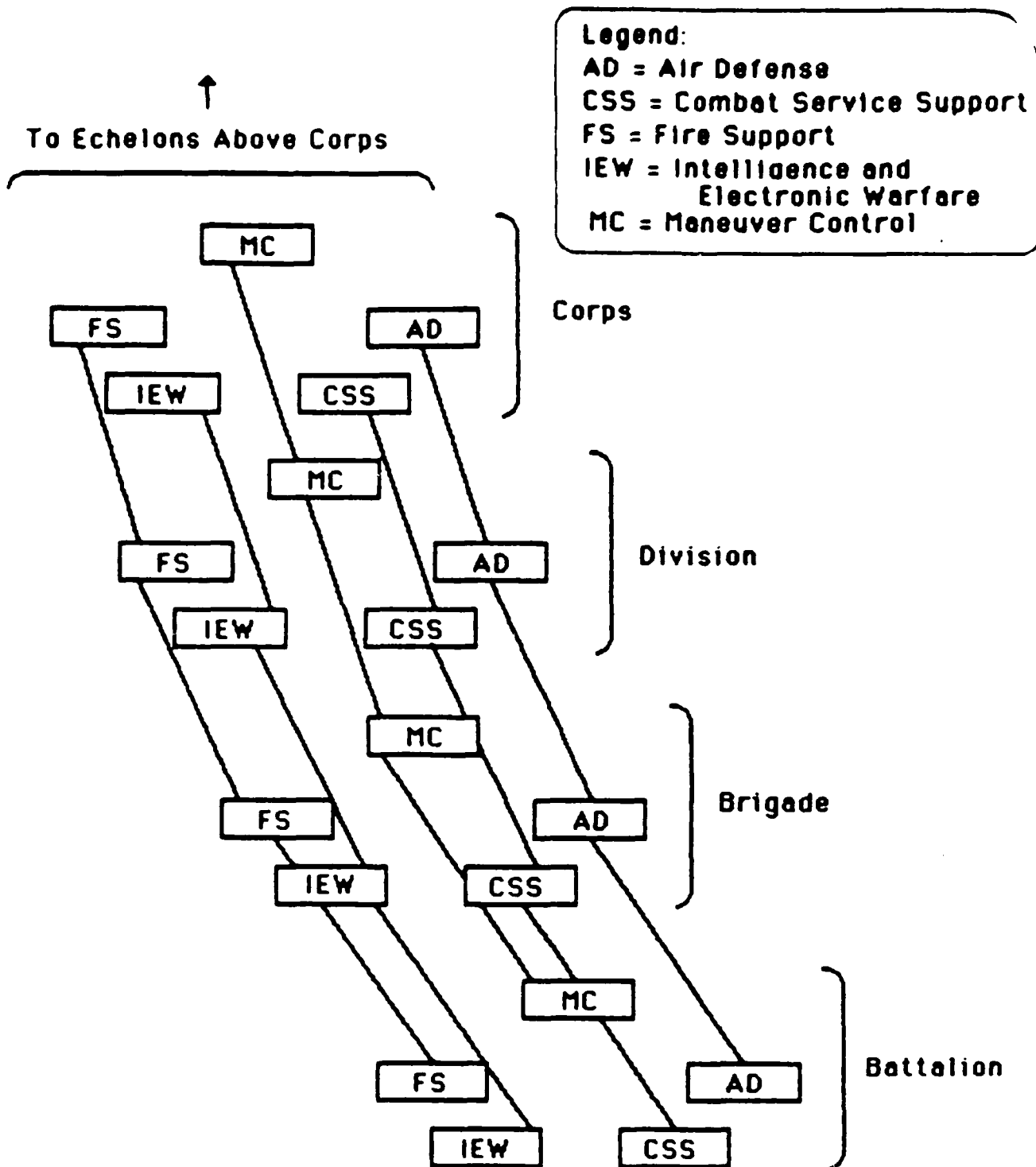
Other Subordinate System-Other BFA

Allied Nation's Command and Control System

Other Service's Command and Control System







## APPENDIX C Functional Area Control Elements

Within each battlefield functional area there exist control elements which play a major role in information processing, allocation, and disseminations. The following matrix was extracted from the 1987 Draft Army Command and Control Master Plan to illustrate the echelons at which control facilities will be initially located in the architecture of new systems.

|           | Maneuver             | Fire<br>Support | Air<br>Defense                                   | Intelligence<br>and<br>Electronic<br>Warfare | Combat<br>Service<br>Support     |
|-----------|----------------------|-----------------|--|--|----------------------------------|
| Corps     | TAC<br>Main<br>Rear  | TAC             | ADA Bde  | TAC Support<br>Element                       | COSCOM                           |
| Division  | TAC<br>Main,<br>Rear | TAC             | Forward<br>Area Air<br>Defense<br>Battalion      | TAC Support<br>Element                       | DISCOM                           |
| Brigade   | Main<br>Rear         | TAC             | Air Battle<br>Management<br>Operations<br>Center | S-2  | Forward*<br>Support<br>Battalion |
| Battalion | Main                 | FSE             |  | S-2*   | S-1/S-4*                         |

\*No Initial Automation Capability

## APPENDIX D. Battalion Relationships with Air Assets

The following matrix depicts the essential information requirements of a ground maneuver battalion for the employment of Army or Air Force air assets. It was extracted from the recently approved final draft of FM 100-103, Army Airspace Command and Control in a Combat Zone.

### Information Required   Received From   Action Officer   Action/Output

OPORD/ OPLAN (includes  
A2C2 Annex)

|            |    |        |      |
|------------|----|--------|------|
| - Brigade  | S3 | S3 Air | P, C |
| -Battalion | S3 | S3 Air | P, C |

A2C2 Control  
Measurements/  
Restrictions

|           |        |        |                        |
|-----------|--------|--------|------------------------|
| -Current  | S3 Air | S3 Air | P, C                   |
| -Required | N/A    | S3 Air | P, C, D<br>-Bde S3 Air |

|      |    |        |     |
|------|----|--------|-----|
| FL0T | S3 | S3 Air | P,C |
|------|----|--------|-----|

|                                |                  |        |     |
|--------------------------------|------------------|--------|-----|
| A2C2 Priorities<br>(Army Only) | S3<br>Bde S3 Air | S3 Air | P,C |
|--------------------------------|------------------|--------|-----|

|             |            |        |   |
|-------------|------------|--------|---|
| AD Warnings | Bde S3 Air | S3 Air | C |
|-------------|------------|--------|---|

|                   |            |        |   |
|-------------------|------------|--------|---|
| Sortie Allocation | Bde S3 Air | S3 Air | P |
|-------------------|------------|--------|---|

Air Support  
Requirements/Requests  
-Army Aviation

|          |                            |        |                    |
|----------|----------------------------|--------|--------------------|
| --Attack | Subordinate<br>Units<br>S3 | S3 Air | C,D<br>-Bde S3 Air |
|----------|----------------------------|--------|--------------------|

|           |       |        |                     |
|-----------|-------|--------|---------------------|
| --Airlift | S4/S3 | S3 Air | C, D<br>-Bde S3 Air |
|-----------|-------|--------|---------------------|

|        |       |        |                     |
|--------|-------|--------|---------------------|
| --SEMA | S2/S3 | S3 Air | C, D<br>-Bde S3 Air |
|--------|-------|--------|---------------------|

|  |            |               |                     |
|--|------------|---------------|---------------------|
| -Air Force                               |            |               |                     |
| --CAS                                    | S3         | S3 Air<br>ALO | C, D<br>-Bde S3 Air |
| --Recon                                  | S2/S3      | S3 Air<br>ALO | C, D<br>-Bde S3 Air |
| --Airlift                                | S4/S3      | S3 Air        | C, D<br>-Bde S3 Air |
| Unscheduled, Large<br>Formation Missions | Bde S3 Air | S3 Air        | C                   |
| ADA Locations                            | ADA Unit   | S3            | C                   |
| ADA Weapons Control<br>Status            | S3         | S3            | C, D<br>BDE         |
| Significant Planned /<br>Ongoing Fires   | DS Arty    | FSO           | C, D<br>-Bde S3 Air |
| Fire Support<br>Coordination Measures    | DS Arty    | FSO           | C                   |
| Field Artillery<br>Locations             | DS Arty    | FSO           | C, D                |
| Army Avn Locations<br>And Coverage       | Avn Units  | S3 Air        | C, D<br>-Bde S3 Air |
| Avn Battle Positions                     | Avn Units  | S3 Air        | C, D<br>-Bde S3 Air |

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|                  |                  |
|------------------|------------------|
| P - Planning     | A - Approval     |
| C - Coordination | D - Distribution |

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## APPENDIX E. Maneuver Control System Operational Characteristics

The following is a verbatim listing of the intended capabilities of the Maneuver Control System hardware and software. It was taken from the Operational and Organizational Plan for the Maneuver Control System.

The MCS will:

1. Integrate the Maneuver Functional Area with four Battlefield Functional Area (BFA) automated systems of Fire Support (FS), Combat Service Support (CSS), Intelligence and Electronic Warfare (IEW), and Air Defense Artillery (ADA) in accordance with the Army's Command Control and Subordinate System (CCS2) architecture.
2. Exchange information as specified in the User Interface Requirements (UIR) documents and be capable of voice transmissions between and within all echelons from battalion thru corps.
3. Exchange standard data elements in standard formats with other BFA control systems within the Army Tactical Command and Control System (ATCCS) using standard tactical communications.
4. Interoperate with other automated systems in the joint and combined environments in compliance with the US message Text Format (MTF) Program (STANAG and JINTACCS) and implement ACCS MTF and BFA unique requirements.
5. Create, display, transmit, receive, print at the same scale as viewed, store and manipulate decision graphics and standard military symbology as specified in the current FM 101 5-1, Operational Terms and Symbols, from the data base entries.
6. Provide Full Military Specification (MILSPEC) components capable of transmitting and receiving digital message traffic while mounted/moving in armored and wheeled command post and command vehicles, and aircraft commonly used as corps, division, brigade, and battalion C2 nodes. MCS Non-Developmental Items (NDI) components, the Tactical Computer Terminal (TCP) and Analyst Console (AC), must be capable of operating in stationary C2 nodes. MCS NDI components will be transported as cargo in wheeled vehicles through it is desired that they will be mountable in the

vehicle to operate after the vehicle stops. The transport of NDI in tracked vehicles is desired, but not required.

7. Provide force level staffs and commanders with ability to plan future operations, analyze alternative courses of action and assess the impacts associated with a particular or related tactical decision. MCS must be able to provide off-line capability to inform commanders and staff of the potential outcomes based on a given set of parameters. The capabilities of Artificial Intelligence (AI) will be applied through software.

8. Provide MILSPEC and NDI equipment capable of operating in a chemically contaminated environment. MILSPEC devices are essential to mission accomplishment, therefore nuclear survivability is required.

9. Improve the management of battlefield information by correlating, filtering, processing, extracting, and formulating information for the force level staffs and commanders.

10. Provide for continuity of operations.

11. Communicate data between devices using existing and planned Army Tactical communications as of 1985. A Local Area Network (LAN) communications capability will be provided for NDI devices. The AC will access tactical communication through a LAN to its host communications modem, the TCP.

12. Receive, store, retrieve, transmit, and print data ranging in classification from UNCLASSIFIED through SECRET with appropriate classification markings without manual encryption.

13. Be air, water, and ground transportable.

14. Provide MILSPEC devices capable of operation, transportation, and storage in climate design types hot, basic, and cold as defined in AR 70-38 and the requirements of MIL-STD (dust/desert). NDI equipment will operate in sheltered facilities in temperatures ranging from 0 - 110 degrees Fahrenheit, and humidities ranging from 10% to 95% (noncondensing without environmental conditioning).

15. Be capable of being operated by soldiers dressing in full NBC environmental protective clothing and equipment (MOPP 4).

16. Provide a Large Printer Plotter to produce large paper and acetate overlays of various map scales from data stored in MCS devices.

17. Provide a Large Screen Display to depict all symbols and decision graphics from data stored in MCS devices.

18. Not create a unique electromagnetic signature, exclusive of data transmission, during device operation.

#### ENDNOTES

1. LTC John Cushman, "What is Command and Control?" (National War College Paper, Washington, D.C., January 1987) pp. 1-2.
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